

Road safety determinants: do political institutions matter?

1. INTRODUCTION

In 2010 the United Nations General Assembly adopted resolution 64/255 declaring 2011–2020 the Decade of Action for Road Safety with the main goal of stabilizing and then reducing the level of road traffic fatalities (United Nations, 2010). Support for this action from the world's governments reflects the growing awareness that road traffic accidents and fatalities constitute a global public health problem. In short, the fact that 1.24 million people lost their lives on the roads in 2010 (World Health Organization [WHO], 2013a) and that traffic injuries were the eighth leading cause of death globally (Lozano et al., 2012) can no longer be overlooked.

The problem is particularly alarming in low- and middle-income countries. According to the WHO, 92% of deaths on roads in 2010 occurred in such countries, although they concentrate just 53% of the world's vehicle fleet (WHO, 2013a). The number of fatalities among vulnerable road users (i.e., pedestrians, motorcyclists and cyclists) is also higher in low- and middle- income countries. In addition, road traffic crashes are associated with high economic costs that seem to hit developing economies hardest, with 59% of fatalities occurring among adults who are often the family's sole breadwinner. A study conducted in Bangladesh and India¹ shows that most families affected by a road traffic fatality experience a significant decline in household income, often causing them to fall below the poverty line (Commission for Global Road Safety, 2007). The loss not only affects the victim's family, but also puts a burden on the nation, whose overall productivity is affected by the exit from the labor market of some of its most productive workers. In 2005 the costs of road traffic crashes in low- and middle-income countries amounted to US\$65 billion, while globally the loss was US\$518 billion, representing between 1 and 3% of the world's gross national product (WHO, 2013a, 2013b).

¹ A study conducted in 2004 by the Transport Research Laboratory commissioned by the Global Road Safety

Partnership. Available at www.grsproadsafety.org

Although some of these losses are unavoidable, many are preventable. Today, road safety is generally assumed to be the shared responsibility of governments and civil society, but reducing the burden of traffic accidents still falls largely on the state authorities. There is substantial evidence from studies of road safety and its determinants to show that governments can play an active role. Taking their lead from Nilsson (2002), for instance, Elvik, Høye, Vaa, and Sørensen (2009) identify 128 road safety measures which governments can use to enhance road safety. These measures address all aspects of road systems and allow ample scope for action in the public sector, where road authorities can be joined by other public institutions – including the health authorities (hospitals, ambulance services), the police force and education authorities – in the provision of road safety. Indeed, public sector policymakers can be viewed as “producers of traffic safety”, which in turn can be characterized as a public good that is “consumed by the general public” (Maier, Gerking, and Weiss, 1989). It is reasonable, therefore, to suppose that if a set of factors has a significant impact on a government’s provision of public goods, these factors should also influence the provision of road safety as a public good.

The research also shows that the quality and quantity of public goods vary systematically according to a country’s political institutions and economic policy. On the one hand, theoretical research on economic policy outcomes has developed and empirically tested several models on how electoral rules and forms of government influence the size and composition of government spending. The models presented by Lizzeri and Persico (2001), Milesi-Ferretti, Perotti, and Rostagno (2002), and Persson and Tabellini (2000) predict that governments elected by proportional representation are more likely to implement public spending programs that benefit large groups of the population. In their theoretical research on the impact of different forms of government on public spending, Persson, Roland, and Tabellini (2000) develop a formal model which predicts that presidential regimes lead to smaller governments and less redistribution than is the case under parliamentary democracies. These predictions are empirically tested by Persson and Tabellini (2004), who find that

electoral rules and forms of government shape the size and composition of government spending. More evidence supporting the theoretical priors is provided in Persson and Tabellini (2003).

Additionally, research on government spending and the provision of public goods under dictatorship and democracy finds that democratization generally has a significant impact on public outlay. McGuire and Olson (1996), among others, predict higher levels of public good provision under democracies than under dictatorships and Bueno De Mesquita, Smith, Siverson, and Morrow (2003), Deacon (2009), Lake and Baum (2001) present empirical evidence to support this, although Mulligan, Gil, and Sala-i-Martin (2004) find no significant difference in the provision of social and economic policies under the two types of regime.

The impact of democratic institutions on policy outcomes can be particularly important in developing countries, whose political institutions have undergone significant transformations in recent decades: less than 10% of low-income and only one third of middle-income countries were democracies in 1975 (Figure 1), while these percentages increased to more than 80% by 2009. The institutional changes brought about by democratization have led to significant modifications in their systems of governance and have had a marked impact on different aspects of the public sector.

<<Insert Figure 1 about here >>

Road safety is one of the outcomes that appear to have benefited from this democratization process: the evidence in Figure 2 shows that democratic institutions are associated with better road safety, which suggests that research should be conducted into the role of institutions and the causal links between democratization and road safety.

<<Insert Figure 2 about here >>

To date, few academic studies have addressed the relationship between institutions and road safety outcomes. Anbarci, Escaleras, and Register (2006) analyzed the association between public sector corruption and traffic fatalities. Grimm and Treibich (2010) used indices of institutional quality to study the effect of income on variability in traffic fatalities. Law, Noland, and Evans (2009)

considered governance and the quality of political institutions to explore the factors underlying the Kuznets curve relationship for motorcycle deaths. But to the best of our knowledge there have been no attempts at assessing the impact of democratic regimes on road safety. The objective of our research, therefore, is to fill this gap by empirically analyzing the effect of democratic institutions on road safety, using panel data models with country-year data. The rest of this paper seeks to answer the question: “What role is played by democratic political regimes, forms of government and electoral rules in shaping road safety outcomes?” Our results make a twofold contribution to the literature. First, they suggest that democratization does have an important and significant impact on the provision of road safety. Second, they show that road safety can be characterized as a local public good. These results have direct and sound policy implications everywhere, but are particularly relevant for developing countries due to their poorer road safety outcomes.

The rest of this paper is organized as follows. Section 2 reviews the literature on institutions as determinants of public policy outcomes. Section 3 examines the literature on road safety determinants. Our data, methodology and empirical models are presented in Section 4. The results are presented and discussed in Section 5. Finally, Section 6 concludes.

2. INSTITUTIONS AND PUBLIC GOOD PROVISION

The literature on economic policymaking analyzes the role played by political institutions in resolving conflicts among groups of voters and politicians. According to Myerson (1995), a political system’s structure and related system of incentives determine political decisions and strategies, influencing government performance. As such, the policy outcomes of this policymaking process tend to be influenced by the prevailing political institutions. This literature addresses different aspects of political institutions: Political systems and electoral systems. The first distinguishes between Political regimes (Democracy vs. Autocracy) and within the democratic regime between the Presidential system and the Proportional system. Regarding electoral systems the literature distinguishes between

majoritarian systems and proportional systems. We start our revision by introducing the literature on political regimes (democracy vs. Authorocracy) and then we review the papers covering the political and electoral organization in democratic systems.

Political Regimes: Democracy vs. Authorocracy

An important strand of the literature on political institutions compares the provision of public goods under authoritarian and democratic regimes. Mulligan et al. (2004) find no significant differences in policy outcomes in economically similar democracies and non-democracies. Stroup (2007) finds that governments with more democratic freedoms do not necessarily generate public policy that effectively provides public goods. However, the theoretical literature generally predicts that fewer resources are allocated to public good provision under dictatorial regimes than under democracies, and this is supported by the empirical papers. For instance, Lake and Baum (2001) construct and empirically test a theoretical model in which states are conceived as natural monopolies for public service provision and they find that fewer public services are provided under dictatorships. In the same vein, Deacon (2009) adapts a model of probabilistic voting to analyze the allocation of a government budget between a public good and transfers under dictatorship and democracy. Deacon's prediction that the level of public good provision is lower in dictatorships than in democracies is supported by results from his empirical analysis. Ghobarah, Huth, and Russett (2004) analyze the effect of political institutions on the level of public health expenditure and on health outcomes, finding that democracy is associated with higher total health spending. Profeta, Puglisi and Scabrosetti (2013) analyze the impact of democracy on military spending, finding an inverted U-shaped relationship between defense expenditure and the strength of democratic institutions. Finally, in the literature on the political economy of investment, Saiz (2006) finds that dictatorships invest more in road quality and quantity.

Political systems in Democratic regimes:

In democratic regimes the literature has paid especial attention to the difference between presidential and proportional systems of government and to the comparison of majoritarian and proportional electoral systems. We divide the literature by reviewing first the models considering political systems alone and electoral systems alone and then the literature combining both aspects.

Political system: Presidential vs. Parliamentary systems

Regarding political systems alone, Persson et al. (2000), for example, propose a public spending model for comparing presidential-congressional and parliamentary regimes and predict that presidential regimes produce smaller governments with inefficiently low spending on public goods. The empirical results corroborate that the size of government is smaller under presidential regimes. Persson and Tabellini's (2000) model is based on the trade-off a candidate faces when making a binding promise to supply a public good that benefits everyone ("universal" spending) or to target redistribution to a specific group or groups ("targetable" spending). The model predicts that parliamentary systems and proportional elections help produce spending programs that allocate revenues more evenly to broad and stable groups of the population.

Electoral systems: Majoritarian vs. Proportional systems

More focused on the electoral system, the model presented by Milesi-Ferretti et al. (2002) examines the trade-off that elected representatives face between allegiance to geographic constituencies and social constituencies, predicting that in proportional systems voters elect representatives prone to spending on transfers, while in majoritarian systems voters elect candidates prone to (local) public good spending. Their empirical results support the theoretical priors of the model. A further theoretical contribution is made by Lizzeri and Persico (2001), in whose politico-economic model office-seeking candidates face a trade-off between allocating public money to public goods or to pork-barrel projects. The model predicts that the proportional system is more efficient

when the public good is very valuable and the winner-take-all system is more efficient when it is not very valuable.

Evidence combining political and electoral systems

The empirical results of Persson and Tabellini (2003) confirmed the previous literature by finding that presidential regimes have smaller governments than parliamentary regimes, and that majoritarian elections induce smaller governments, generate less welfare spending and smaller deficits than those resulting from proportional elections. Similar results are obtained in Persson and Tabellini (2004), who find that majoritarian elections lead to smaller governments and smaller welfare programs, while presidential regimes induce smaller governments than parliamentary democracies. However, Albalade, Bel, and Elias (2012) find that military spending is greater in presidential democracies with majoritarian electoral rule, suggesting that in contrast to theoretical predictions in the literature, political institutions do not have the same impact on the provision of all public goods.

All in all, our literature review yields sound empirical evidence that the level of public good provision depends on a country's political institutions, making it reasonable to suppose that the provision of road safety as a public good will vary across countries governed by different political institutions. First, the literature suggests that authoritarian regimes provide fewer public goods, and we would therefore expect authoritarian countries to have poorer road safety outcomes. Second, presidential democracies with majoritarian electoral rule are found to have smaller governments and spend less on public goods than do parliamentary democracies with proportional electoral systems. We expect countries with presidential systems and majoritarian electoral rule to have higher numbers of traffic accidents and fatalities. We test these hypotheses with a panel data that controls for political institutional variables and other road safety determinants. The following section reviews the literature on these other factors.

3. RESEARCH ON ROAD SAFETY DETERMINANTS

Much of the academic work on road safety focuses on the effectiveness of road safety measures that neutralize and diminish the risk factors of traffic accidents, injuries and fatalities. Three main groups of measures – user-associated measures, concerned with road-user behavior; vehicle-related measures, aimed at improving vehicle safety; and road infrastructure-related measures – are commonly explored in the literature. The research concerned with road-user behavior and in-car safety analyzes the impact of traffic regulations and their enforcement as well as their conduct and education, while the literature on road infrastructure-related measures assesses the effects of road characteristics and traffic conditions.

Among recent studies evaluating the implementation and enforcement of regulatory measures, many papers evaluate the effect of speed limit modification. They report mixed results and suggest that the effect of speed limit modifications is uneven and may be divergent for different groups of drivers (for example, see Dee and Sela, 2003; Tay, 2009). The effectiveness of seat belt laws is also extensively analyzed. Carpenter and Stehr (2008) and Cohen and Einav (2003) find that seat belt usage has a positive impact on road safety, while other papers (e.g., Derrig, Segui-Gomes, Abtahi, and Ling-Ling, 2002) find little or no evidence of safety belt effectiveness. The restrictive regulation of blood alcohol limits is generally found to be effective in improving road safety (see, amongst others, Albalade, 2008; Kaplan & Prato, 2007). This positive effect on road safety does not hold for the mandatory periodic motor vehicle inspection (see Christensen and Elvik, 2007; Sutter and Poitras, 2002).

Studies on the impact of road infrastructure usually report mixed results and seem to be dependent on particular cases and on the variables taken into account (Albalade et al., 2012). For instance, Anastasopoulos, Tarko, and Mannering (2008), Flahaut (2004), Park, Carlson, Porter, and Andersen (2012), all find positive effects of better quality roads (broader lane-width, larger number of lanes, better paving, median strips and shoulders), while the results obtained by Noland (2003)

undermine the hypothesis that improvements in road infrastructure effectively reduce fatalities and injuries. This divergence seems to be mostly due to the strength of the Peltzman effect (Peltzman, 1975), where drivers respond to improved safety measures by taking greater risks and so offset the effectiveness of the improved road infrastructure. Many studies (e.g., Haynes et al., 2008) also report that traffic conditions constitute an important determinant of road safety.

Another strand of literature on the determinants of road safety investigates the effect of socioeconomic variables. Some of these studies also consider the effect of institutions. For instance, the research by Jacobs and Cutting (1986) explores the relationship between the fatality rate and socio-economic and physical characteristics of developing countries such as per capita GDP, the number of circulating vehicles, road density, vehicle density, population per physician and population per hospital bed. It finds that the variable that has the greatest impact on the number of fatalities is vehicle ownership, and that per capita GDP, vehicle density and population per hospital bed are contributing factors.

In their research on the relationship between traffic fatalities and economic development, Anbarci et al. (2006) find that a decrease in public sector corruption reduces traffic deaths, and that the number of fatalities increases in income up to a threshold of US\$15,000 and then decreases. These results are obtained for a cross-country panel data set where the variation in the number of road traffic fatalities is explained by the level of public sector corruption and other socio-economic variables (per capita GDP, illiteracy and fatality rates, motorization, population structure).

Another analysis of the effect of economic growth on traffic fatalities in low- and high-income countries is conducted in Bishai, Quresh, James, and Ghaffar (2006). The findings show that in low income countries per capita GDP growth is associated with an increase in traffic crashes, injuries and deaths, while in high income countries the increase in per capita GDP lowers the number of traffic fatalities but does not alter the number of crashes and injuries.

Law et al. (2009) also estimate the relationship between per capita income and traffic fatalities investigating the Kuznets curve relationship for motorcycle deaths. Using political rights and corruption indices as proxies for governance and the quality of political institutions, the authors find an inverted U-shaped relationship between motorcycle deaths and per capita income. They also find that the implementation of road safety regulations and the improvement of institutional quality, medical care and technology significantly reduce motorcycle deaths.

According to Grimm and Treibich (2010), the results of the inverted U-shaped relationship between income and traffic fatalities must be interpreted with caution. They suggest that income is a proxy for such factors as road network quality, the degree of motorization and the implementation and enforcement of regulations, and that it affects road safety through channel variables such as population and traffic density, risk-taking behavior or alcohol consumption. They find that the U-shaped relationship between income and road traffic fatalities does not hold when the effect of income on the variability of fatalities is disentangled from the effect of the channel variables. Neither does the effect of income seem significant in explaining the variation in fatalities within high- and low-income countries.

Vereeck and Vrolix (2007) also argue that per capita income must be treated as a complex indicator that comprises several factors: the average age of the vehicle fleet, road construction and maintenance, education level and economic conditions. Controlling for these factors and for traffic exposure, population characteristics and alcohol consumption, the authors explore how social willingness to comply with the law affects driver behavior and traffic fatalities. They find that social willingness to comply is an important factor and that this matters more to drivers than the content of the legal rule (legal specificity).

From this literature review we can conclude that there is a consensus on the set of factors that are most relevant to road safety: traffic exposure, road infrastructure characteristics, socio-

economic variables, traffic regulation and driver behavior.² The aim of our research is to implement a model to predict cross-country road safety variability using these safety factors and a further set of explanatory variables associated with democratic institutions. To our knowledge, this is the first time this kind of modeling has been conducted.

4. DATA AND METHODOLOGY

To analyze the relationship between institutions and road safety we employ a panel of annual country data. The panel includes data for 138 countries over 35 years (1975-2009). These data comprise information on traffic fatalities, accidents with injuries, institutional variables and other controls (road network quality, traffic exposure and socio-economic variables). The detailed information on our variables and data sources is given in Appendix Table A1 and the summary of the descriptive statistics is provided in Table 1. Unfortunately, the total number of observations in our analysis has been reduced due to missing values, so we have to deal with an unbalanced data set.

<<Insert Tables 1 about here >>

We employ Hausman's (Hausman, Bronwyn and Griliches, 1984) negative binomial regression model, a specification that has been shown to yield a good fit for the analysis of count data, such as the number of traffic accidents and fatalities, and which has become the most frequently used specification in crash-frequency modeling (Lord and Mannering, 2010). Negative binomial estimators are more efficient than Poisson estimates because they control for the overdispersion commonly present in count data (Cameron and Trivedi, 2009). The descriptive statistics of our dependent variables reported in Table 1 show that the unconditional means of fatality and accident counts are much lower than their variance, which indicates the presence of overdispersion and suggests that the negative binomial model is an appropriate specification. In addition, overdispersion can be

² A detailed study of the effects of a range of different factors on road safety can be found in Bester (2000).

exacerbated in longitudinal, clustered or unbalanced data (Hilbe, 2007). This gives yet another rationale for using negative binomial model instead of Poisson model with our data.

The reasonable within- and between-variability of all the dependent variables (Table 2) facilitates the use of the conditional fixed-effects negative binomial model. In addition, for our data that pools many heterogeneous countries together, this model is appropriate because country fixed effects allow to control for any unobserved country heterogeneity which is fixed over time, such as vehicle fleet conditions, drivers' attitudes and behaviors, weather and geographical conditions, culture, and the like. In this manner, we overcome the problem of omitted variable bias by collecting all omitted time-invariant information in the fixed effects. In addition, fixed-effects specification allows to capture differences across countries in terms of country's definition of fatalities and accidents with injuries (Anbarci et al. 2006). Finally, fixed-effects estimation allows correlation between any unobserved heterogeneity and covariates, as well as between common unobserved effects and the dependent variables. The alternative random-effects model gives inconsistent estimates if shared unobserved effects are correlated with the regressors. Hence, our preferred specification is fixed-effects model.³

<<Insert Table 2 about here >>

We estimate two models. Model 1 (Eq. 1) is employed for the full sample. Here we assess the effect of democratization on road safety. Model 2 (Eq. 2) is an extended model, in which we incorporate institutional variables that identify two specific traits of democracies: the electoral rule

³ We conduct all our empirical analyses using `xtnbreg` Stata13 command. We were not able to implement an estimation protocol similar to Stata's `hausman` or `suest` procedure after `xtnbreg` command. As a rough approximation, for all analyses we performed Hausman test after running random- and fixed-effects specification using Stata's `xtreg` command. For all analyses, we obtained large and significant Hausman statistics, indicating that fixed effect specification is appropriate. Anyway, results keep consistent when implementing random-effects models without meaningful differences.

and the form of government. Model 2 is, therefore, estimated only for democratic countries and examines the effect of the traits of democracy on road safety.

$$\ln(\lambda_{it}) = \ln(\text{vehkm}_{it}) + \delta \text{Leveldemocr}_{it} + \beta X_{it} + TE_t + s_i + \varepsilon_{it} \quad (1)$$

$$\ln(\lambda_{it}) = \ln(\text{vehkm}_{it}) + \delta_1 \text{Leveldemocr}_{it} + \delta_2 \text{Presidential}_{it} + \delta_3 \text{Major}_{it} + \beta X_{it} + TE_t + s_i + \varepsilon_{it} \quad (2)$$

where $i=1, \dots, N$; $t=1, \dots, T_i$

The dependent variable λ_{it} is the expected value of Y_{it} and $\text{Var}(Y_{it}) = \lambda_{it} (1 + a_i)$ where a_i is the rate of overdispersion for each country. Y_{it} is either the number of traffic fatalities (*fat*) or the number of traffic accidents resulting in injuries (*accinj*). We implement these two variables to identify two dimensions of road safety: the severity of accidents captured by the fatality counts, and a broader measure captured by the number of accidents.

Eq. (1) is estimated for the full sample of countries and the institutional variable considered here is *leveldemocr*. It takes values from 1 to 7, where 1 is given to the least democratic countries and 7 to the most democratic countries.⁴ Eq. (2) is estimated for democratic countries only (*leveldemocr* is equal to 6 or 7) and, in addition to the *leveldemocr* institutional variable, the model employs *presidential* and *major* binary variables. These variables take a value of one, respectively, if the democracy is presidential and if the electoral rule is majoritarian. Otherwise, they take a value of zero.

Vector X_{it} collects (1) the time-varying controls related to the quality of the road network, i.e., the density of the road network (*density*), the share of motorways (*sharemw*) and the share of paved roads (*paved*)⁵, and (2) the socio-economic time-varying controls, i.e., the logarithm of per capita GDP

⁴ See Appendix Table A1 for more information on how the *leveldemocr* variable is constructed

⁵ Since the *sharemw* variable has more missing values than *paved*, we employ *paved* rather than *sharemw* in the second model (estimated only for democratic countries) to maintain a stable number of observations across the two models. The variation over time in the variables *density*, *sharemw* and *paved* represents 90.48%, 59.81% and 9.24% of the total variation, respectively.

(*lgdppc*), the growth of per capita GDP (*grthgdppc*), the urban population concentration (*urbrate*) and the share of people over 65 years old (*pop65up*).

TE_t is a vector of variables related to time effects. First, we introduce a general time trend (*trend*) for all countries in order to account for the time patterns affecting road safety. Then, we replace the general trend with three different time trends: for low-income countries (*trendl*), middle-income countries (*trendm*) and high-income countries (*trendh*), to control for possible divergent time patterns between countries of different income levels. In the second model we introduce year-specific dummy variables for the first ten years following democratization to quantify the dynamics of the process.

N is the number of countries, T_i is the year for the i -th country and ε_{it} is the error term. Finally s_i denotes a country-specific fixed. The parameters of the model are estimated by the maximum likelihood method using Stata's `xtnbreg` command. The number of vehicles per km network (*vehkm*) is an offset variable⁶ accounting for the fact that countries with a higher level of motorization per network kilometer should have more traffic accidents and fatalities. In the estimation the coefficient of its logarithm is restricted to one.

5. RESULTS

First, we assess the effect of democratic institutions on traffic fatalities and accidents (Model 1). The results are displayed in Tables 3 and 4.⁷ Then, we assess the impact of two dimensions of

⁶ While traffic volume might be better as the offset, the variable available in the IRF's WRS database has a lot of missing values. We do not employ it in our final estimations, but we check the consistency of our results by estimating both models with the traffic volume offset variable. This modification does not substantially alter our original results.

⁷ Note that due to missing information the number of observations finally used is 1143 in fixed-effects for fatality model (1) of table 3. The final amount of countries that remain for fatality model (1) is 99 and for accident counts model (1) is 96, with a larger presence of democracies than authoritarian regimes as

democracy: the form of government and the electoral rule (Model 2). The results are shown in Tables 5 and 6. In each of these tables (3 through to 6), column (1) displays the results for estimations without trend variables, while columns (2) and (3) show the results for estimations with general trend and with three income-specific time trends, respectively. In Tables 5 and 6, column (7) is added to show our results for the regressions with year-specific dummy variables for the first ten years after countries become democratic. We illustrate the coefficient estimates for these year-specific dummies in Figures 3 and 4 for both fixed and random effects. The pairwise correlation coefficients for the variables with at least one correlation coefficient higher than 0.40 in absolute value are reported in Table 7.⁸

<<Insert Tables 3,4, 5, 6, 7 about here >>

Institutional variables

As expected, democratic institutions have a marked impact on road safety. The coefficient estimates of the *leveldemoc* variable are negative across all regressions and statistically significant in

expected. The only patterns identified for this attrition rate are observable and already included - and thus controlled - by the model specification. From 120 countries that are classified as democratic at least once, 100 are in the final sample employed to estimate the results shown in table 5, and 80 are in the sample employed to obtain the results shown in table 6. We do not identify any pattern for this attrition in the models considering only democracies. Therefore, we believe that missing observations can be considered randomly distributed.

⁸ Some of our control variables show relatively high pairwise correlation. Nonetheless, excluding these variables showed no significant alteration in coefficient estimates for other covariates, suggesting the absence of multicollinearity problem.

all but one. The negative sign suggests that democracy has a positive effect on road safety.⁹ This result is applicable not only to countries in a process of democratic transition but also to established democracies consolidating their democratic institutions. The results for the traffic accident counts in the estimation for the full sample are particularly notable because of the high statistical significance (p-values smaller than one percent) for all institutional variables' coefficient estimates. This outcome is in line with the theoretical prediction that more democratic regimes are associated with higher levels of public good provision.

Our empirical results for the voting system show that the majoritarian voting rule has a positive effect on road safety, reducing the number of traffic fatalities. This can be interpreted using the model developed by Persson, Roland, and Tabellini (1999), which draws on the differentiation between systems of majoritarian and proportional representation based on district magnitude: under the proportional electoral system there is a single electoral district, while majoritarian systems use multiple-district elections. The difference in district magnitude across the two systems results in differences in public good provision: fiercer competition for the marginal district in majoritarian systems leads to smaller internalization of voter costs and benefits and, hence, to a lower level of public good provision than in proportional systems. A further theoretical result is offered by Milesi-Ferretti et al. (2002). In this model, the proportional system voters elect representatives whose spending satisfies a great variety of interests nationwide, while in majoritarian systems voters elect candidates committed to local public good spending. Consequently, one explanation for our empirical findings may be that voters consider road safety to be more properly a local public good, and give more incentives to increase its provision to politicians elected in majoritarian systems.

⁹ Instead of *leveldemoc* we also conducted the estimations with a binary variable which takes a value of one if the country is democratic and zero otherwise. The coefficient estimates obtained for this variable are statistically significant and negative, and its inclusion does not qualitatively alter the estimates for other regressors.

Our results for the form of government suggest that there are more traffic accidents in presidential than in parliamentary democracies. This confirms the prediction that presidential democracies provide lower levels of road safety as a public good than parliamentary democracies. The effect on traffic fatalities is not clear, since all but one coefficient estimates for the form of government are statistically non-significant.

Road infrastructure quality variables

The coefficient estimate on road network density for traffic fatalities and accidents is positive and statistically significant in the Model 1. The sign of the coefficient indicates that the number of traffic fatalities and accidents increases with increasing road density, since denser networks might mean that the greater supply of roads induces greater demand and, hence, more accidents. The effect is not evident in Model 2, where the coefficient estimates are mostly non-significant and, on occasions, negative and significant at the five and ten per cent levels.

The effect of the share of paved roads on road safety is beneficial: the sign of the coefficient estimates for both traffic fatalities and accidents is negative and statistically significant. This result is largely intuitive since we expect a larger number of paved roads to enhance road safety.

The coefficient estimates for the share of motorways are positive and statistically significant in the estimation for traffic fatality counts. This suggests that a larger number of motorways has a negative effect on road safety, possibly because of the higher demand induced by a greater supply of better roads and because of the Peltzman effect (see explanation in Section 3 above). The estimations for the accident counts yield negative and statistically significant coefficients when time trends are not considered and positive and significant coefficients when the three income-specific trends are included. This may be explained by the significance of the time trends, which capture the improvement in road infrastructure technology.

Socio-economic variables

The concentration of population in urban areas displays a significant negative effect on road safety across both models. This result is consistent with the literature, which reports a higher relative risk of accidents with injuries in urban areas (Elvik et al., 2009). The increase in per capita GDP seems to have a negative effect on road safety by increasing the number of traffic fatalities. However, the coefficient is significant only in the regressions without time trends in Model 1 and without income-specific time trends in Model 2, which may be explained by higher rates of motorization leading to more traffic crashes and deaths in developing economies. The negative and statistically significant coefficient estimates for the income-specific control variable suggest that high income countries experience fewer accidents and fatalities from traffic crashes. The result for the elderly population control variable presents a positive sign in estimations for traffic accident counts. In the estimations for fatality counts without time trends the greater proportion of elderly people results in fewer fatalities. When the time trends are included, the coefficient estimates become either positive and statistically significant or non-significant. This change may be explained by the significance of the time trends, which capture the improvement in medical technology that is essential for the post-crash medical care associated with a smaller number of deaths caused by traffic accidents.

Trends and time effect variables

The general time trend and the trends for high- and middle-income countries are negative and statistically significant across both models. The negative signs of the coefficient suggest that growing public awareness of road safety and improvements in technology have a very clear and positive effect on road safety. This positive dynamic seems to occur only in high-income countries, since the coefficient estimates for the low-income countries are non-significant in the estimations for fatality counts and positively significant in the estimations for accident counts. The notable difference between the coefficient estimates associated with the time trends for middle- and high-income

countries¹⁰ supports the conclusion that the richer the country, the greater the rewards of improved road safety. In addition, the significance of the time trends may show that road safety benefits from other important factors not included in our regressions. This is important for our analysis, since we cannot rely on either regulation or enforcement variables. Among other time varying factors, the favorable effect of traffic laws on road safety can be captured by significant negative time trends.

Interesting results are obtained for the timing effects of democratization on road safety. Our analysis is similar to analyses on democratic transitions and economic growth (Papaioannou and Siourounis, 2008), and to the literature assessing the lag in effectiveness of road safety regulations (e.g., Albalade, 2008; or Eisenberg, 2003). The dynamics of the timing effects for the results reported in Table 5 are shown in Figure 3 and for the results reported in Table 6 are shown in Figure 4. They suggest that (1) a country's transition from autocratic to democratic regime is associated with a decline in the number of traffic fatalities and accidents; (2) there is a delay of four years before democratization starts to have a significant effect on road safety; (3) considering the sizes of coefficients, the impact of democratization becomes greatest in the sixth year of the country's transition. Our test of joint statistical significance of ten post democratization year-specific dummies rejects the null hypotheses that the set of timing effects is not significant.

<<Insert Figures 3, 4 about here >>

6. CONCLUSIONS

International institutions and national governments alike recognize that the deaths and injuries resulting from road traffic accidents are a major public health concern, above all in low- and middle-income countries. Although some of these losses are unavoidable, many are preventable.

¹⁰ Our tests find that the difference between coefficient estimates associated with the high- and middle-income trend variables is statistically significant.

Today, reducing the burden of traffic accidents falls largely on the state authorities and, in this regard, governments can be seen as producers and the general public as consumers of road safety as a public good. Drawing on the results from the research on political institutions and economic policy, which indicate that public good provision varies systematically with the political institutions allocating public revenues, we argue that the level of provision of road safety is likewise influenced by the prevailing political institutions.

The descriptive statistics presented in the introduction to this paper and the results of our empirical study show that political institutions do play an important role in determining the toll of traffic accidents and fatalities. Above all, our results suggest that lower rates of fatalities and accidents are associated with democracies, and that the process of democratization has a beneficial and significant effect on road safety. Democratization would therefore seem to be an important process for stabilizing and then reducing the level of road traffic fatalities. However, we find that democratization does not have an immediate impact, it requiring around four years for its effects to start becoming statistically noticeable. This suggests that democratic institutions need time to set up the bodies and implement the policies that produce better road safety outcomes. Yet, having said this, it is surprising just how quickly the effects become statistically significant. Interestingly, not only the beneficial effects of democratization apparent in countries making the transition to democracy, but they are also discernible in established democracies that are consolidating their political institutions.

The role of democratic institutions on road safety is particularly significant in the low- and middle-income countries that were at the epicenter of the democratization process which took place in the last decades of the twentieth century. Yet, their performance in this area still leaves much to be desired. Reports issued by the international institutions claim that low- and middle-income countries continue to underperform on issues of road safety because of a lack of funding and political concern. Indeed, even though the health costs attributable to road traffic injuries are comparable to those of

malaria and tuberculosis, the fight against disease attracts greater political concern and financial support. Our characterization here of road safety as a local public good perhaps corroborates the evidence that it remains a secondary objective. In comparison, healthcare justifiably is given priority status, as low-income countries concentrate their efforts on disease prevention and eradication.

However, simply raising political awareness and increasing public spending on road safety are insufficient. If strong efficient institutions are not created, the general indifference to traffic laws and the authorities that enforce them can hamper effective outcomes. To understand more clearly the effect of these factors, future research needs to focus on the variables of regulation, enforcement and compliance. The consideration of road safety as the shared responsibility of governments and civil society suggests that social capital can also be a significant factor in this approach. Lake and Baum (2001, p. 619) showed how important are the context constraints imposed by citizens and by the society to politicians. As they argue, “democracy is the instrument that allows the state to do good while tempering its capacity for exploitation [...] and lowers the costs of removing officials from office. By making the political market more contestable, it constrains the monopoly power of the state and improves the material conditions of everyday life”. Social capital and the shared social responsibility on road safety must be, therefore, a relevant constraint that must influence and promote the appropriate policies that must improve road safety as a public good for the society.

Overall, our research shows that the inclusion of institutional variables in the analysis of road safety determinants provides new insights in the analysis of traffic safety and the provisions of public goods. But if we are to alleviate the burden imposed by traffic accidents, especially in the world’s poorest economies, we need a better understanding of the causal links between political institutions and road safety.

REFERENCES

- Albalade, Daniel, 2008. Lowering blood alcohol content levels to save lives: the European experience. *Journal of Policy Analysis and Management* 27(1), 20–39.
- Albalade, Daniel, Bel, Germà, Elías, Ferran, 2012. Institutional determinants of military spending. *Journal of Comparative Economics* 40(2), 279-290.
- Anastasopoulos, Panagiotis C., Tarko, Andrew P., Mannering, Fred L., 2008. Tobit analysis of vehicle accident rates on interstate highways. *Accident Analysis and Prevention* 40(2), 768–775.
- Anbarci, Nejat, Escaleras, Monica, Register, Charles, 2006. Traffic fatalities and public sector corruption. *Kyklos* 59(3), 327–344.
- Bester, Christo J., 2000. Explaining national road fatalities. *Accident Analysis and Prevention* 33, 633-672.
- Bishai, David, Quresh, Asma, James, Prashant, Ghaffar, Abdul, 2006. National road casualties and economic development. *Health Economics* 15(1), 65-81.
- Bueno De Mesquita, Bruce, Smith, Alastair, Siverson, Randolph M., Morrow, James D., 2003. *The logic of political survival*. MIT Press, Cambridge, MA.
- Cameron, A. Colin, Trivedi, Pravin K., 2009. *Microeconometrics using Stata*. Stata press, Texas, the USA.
- Carpenter, Christopher S., Stehr, Mark, 2008. The effects of mandatory seatbelt laws on seatbelt use, motor vehicle fatalities, and crash-related injuries among youths. *Journal of Health Economics* 27(3), 642-662.

Christensen, Peter, Elvik, Rune, 2007. Effects on accidents of periodic motor vehicle inspection in Norway. *Accident Analysis and Prevention* 39(7), 47–52.

Cohen, Alma, Einav, Liran, 2003. The effects of mandatory seat belt laws on driving behavior and traffic fatalities. *Review of Economics and Statistics* 85(4), 828–843.

Commission for Global Road Safety (CGRS), 2007. Make roads safe. A new priority for sustainable development. Available at <http://www.makeroadssafe.org/about/Pages/homepage.aspx>. CGRS, UK.

Deacon, Robert T., 2009. Public good provision under dictatorship and democracy. *Public Choice* 139, 241–262.

Dee, Thomas S., Sela, Rebecca J., 2003. The fatality effects of highway speed limits by gender and age. *Economics Letters* 79, 401–408.

Derrig, Richard A., Segui-Gomes, Maria, Abtahi, Ali, Ling-Ling, Liu, 2002. The effect of population safety belt usage rate on motor vehicle-related fatalities. *Accident Analysis and Prevention* 34, 101–110.

Elvik, Rune, Høy, Alena, Vaa, Truls, Sørensen, Michael, 2009. *Handbook of road safety measures* (2nd edition). Emerald Group Publishing Limited, Bingley, UK.

Eisenberg, Daniel, 2003. Evaluating the effectiveness of policies related to drunk driving. *Journal of Policy Analysis and Management* 22, 249–274.

Flahaut, Benoît, 2004. Impact of infrastructure and local environment on road unsafety. Logistic modeling with spatial autocorrelation. *Accident Analysis and Prevention* 36, 1055–1066.

Grimm, Michael, Treibich, Carole, 2010. Socio-economic determinants of road traffic accident fatalities in low and middle income countries. ISS working paper 504. International Institute of Social Studies, The Hague.

Ghobarah, Hazem Adam, Huth, Paul, Russett, Bruce, 2004. Comparative public health: the political economy of human misery and well-being. *International Studies Quarterly* 48(1), 73-94.

Hausman, Jerry, Bronwyn, H. Hall, Griliches, Zvi, 1984. Econometric models for count data with an application to the patents-R&D relationship. *Econometrica* 52, 909–938.

Haynes, Robin, Lake, Iain R., Kingham, Simon, Sabel, Clive E., Pearce, Jamie, Barnett, Ross, 2008. Influence of road curvature on fatal crashes in New Zealand. *Accident Analysis and Prevention* 40, 843–850.

Hilbe, Joseph, 2007. *Negative Binomial Regression*. Second edition. Cambridge University Press, Cambridge, UK.

Persson, Torsten, Tabellini, Guido, 2000. *Political economics: explaining economic policy*. MIT Press, Cambridge, MA.

Jacobs, G.D., & Cutting, C. A., 1986. Further research on accident rates in developing countries. *Accidents Analysis and Prevention* 18(2), 119-27.

Kaplan, Sigal, Prato, Carlo Giacomo, 2007. Impact of BAC limit reduction on different population segments: a Poisson fixed effect analysis. *Accident Analysis and Prevention* 39, 1146–1154.

Keefer, Philip, 2010. *Database of Political Institutions DPI 2010*. Development Research Group, The World Bank, Washington, DC.

Lake, David A., Baum, Matthew A., 2001. The invisible hand of democracy: political control and the provision of public services. *Comparative Political Studies* 34(6), 587-621.

Law, Teik Hua, Noland, Robert B., Evans, Andrew W., 2009. Factors associated with the relationships between motorcycle deaths and economic growth. *Accident Analysis and Prevention* 41(2), 234-240.

Lizzeri, Alessandro, Persico, Nicola, 2001. The provision of public goods under alternative electoral incentives. *American Economic Review* 91(1), 225-239.

Lord, Dominique, Mannering, Fred, 2010. The statistical analysis of crash-frequency data: a review and assessment of methodological alternatives. *Transportation Research (A)* 44, 291–305.

Lozano, Rafael, Naghavi, Mohsen, Foreman, Kyle, Lim, Stephen, Shibuya, Kenji, Aboyans, Victor, ... Murray, Christopher J. L., 2012. Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010 *Lancet* 380(9859), 2095-2128.

Maier, Gunther, Gerking, Shelby, Weiss, Peter, 1989. The economics of traffic accidents on Austrian roads: risk lovers or policy deficit? *Empirica* 16, 177-192.

Milesi-Ferretti, Gian Maria, Perotti, Roberto, Rostagno, Massimo, 2002. Electoral systems and the composition of public spending. *Quarterly Journal of Economics* 117, 609-657.

Mulligan, Casey B., Gil, Ricard, Sala-i-Martin, Xavier, 2004. Do democracies have different public policies than nondemocracies? *Journal of Economic Perspectives AEA* 18(1), 51-74.

Myerson, Roger. B., 1995. Analysis of democratic institutions: structure, conduct and performance. *Journal of Economic Perspectives* 9(1), 77-89.

Nilsson, Göran, 2002. The three dimensions of exposure, risk and consequence. Unpublished manuscript. Swedish national road and transport research institute, Linköping.

Noland, Robert B., 2003. Traffic fatalities and injuries: the effect of changes in infrastructure and other trends. *Accident Analysis and Prevention* 35, 599–611.

Park, Eun Sug, Carlson, Paul J., Porter, Richard J., Andersen, Carl K., 2012. Safety effects of wider edge lines on rural, two-lane highways. *Accident Analysis and Prevention* 48, 317–325.

Papaioannou, Elias, Siourounis, Gregorios, 2008. Democratisation and growth. *The Economic Journal* 118, 1520-1551.

Peltzman, Sam, 1975. The effects of automobile safety regulation. *Journal of Political Economy* 83(4), 677–725.

Persson, Torsten, Roland, Gerard, Tabellini, Guido, 1999. The size and scope of government: comparative politics with rational politicians. *European Economic Review* 43, 699–735.

Persson, Torsten , Roland, Gerard, Tabellini, Guido, 2000. Comparative politics and public finance. *Journal of Political Economy* 108, 1121-1141.

Persson, Torsten, Tabellini, Guido, 2000. *Political economics: explaining economic policy*. MIT Press, Cambridge, MA.

Persson, Torsten, Tabellini, Guido, 2003. *The economic effect of constitutions*. MIT Press, Cambridge, MA.

Persson, Torsten, Tabellini, Guido, 2004. Constitutional rules and fiscal policy outcomes. *American Economic Review* 94(1), 25-45.

Profeta, Paola, Puglisi, Riccardo, Scabrosetti, Simona, 2013. Does democracy affect taxation and public spending? Evidence from developing countries. *Journal of Comparative Economics* 41, 684–787.

Saiz, Albert, 2006. Dictatorships and highways. *Regional Science and Urban Economics* 36, 187-206.

Stroup, Michael D., 2007. Economic freedom, democracy and the quality of life: an empirical analysis. *World Development* 35(1), 52–66.

Sutter Daniel, Poitras, Marc, 2002. The political economy of automobile safety inspections. *Public Choice* 113, 367-387.

Tay, Richard, 2010. Speed cameras: improving safety or raising revenue? *Journal of Transport Economics and Policy (A)* 44(2), 247–257.

United Nations (UN), 2010. Resolution adopted by the General Assembly. 64 / 255 Improving global road safety. Available at http://www.who.int/violence_injury_prevention/publications/road_traffic/UN_GA_resolution-54-255-en.pdf. UN, NY.

Vereeck, Lode, Vrolix, Klara, 2007. The social willingness to comply with the law: the effect of social attitudes on traffic fatalities. *International Review of Law and Economics* 27(4), 385–408.

World Bank (WB), 2012. World Development Indicators. Available at <http://data.worldbank.org/data-catalog/world-development-indicators>. WB, Washington D.C.

World Health Organization (WHO), 2013a. Global Status Report on Road Safety 2013. WHO, Geneva.

World Health Organization (WHO), 2013b. Road traffic injuries (Fact sheet N°358, March 2013). Available at <http://www.who.int/mediacentre/factsheets/fs358/en/>. WHO, Geneva.